

## APPENDIX A: TREE MARKING AND RETENTION GUIDELINES

The information in this Appendix was taken from the Wisconsin DNR *Silviculture Handbook, 24315.24*, Chapter 24 (dated March 2009). The purpose of Chapter 24 is to:

- Provide silvicultural guidelines for selecting trees to retain and remove to accomplish specific stand management objectives.
- Provide recommendations for stand-level tree and snag retention to accomplish sustainable forest management goals.
- Recommend content of written marking guidelines for prescription implementation.
- Clarify concepts and considerations related to why and how trees are selected and marked, including appropriate silvicultural methods.
- Clarify silvicultural terminology.

### TIMBER MANAGEMENT – CROP TREE SELECTION

Timber crop trees are trees selected to become a component of a future commercial harvest. These trees are selected for retention and their crowns released from competition to optimize tree vigor and focus growth on the most desirable trees. Sawtimber crop trees are the best quality, high vigor trees of desirable species that are targeted for (near) final harvest; they will be grown to rotation age or maximum desired size class.

General Sawtimber Crop Tree Selection Criteria:

- Low risk of mortality or failure (main stem breakage)
- Good crown vigor
- Good timber quality
- Desirable species

Crop tree management is an important part of most marking operations. The number of crop trees to retain and the desired residual stand density depend on management objectives, silvicultural methods, forest type and species, stand and tree condition, and site.

In addition to timber crop trees, identify and retain other trees to provide multiple benefits. The selection of trees for retention strongly influences which trees will be cut.

### TIMBER MANAGEMENT – SELECTING TREES TO CUT AND THE STANDARD ORDER OF REMOVAL

Before selecting trees to cut, identify desired residual stand composition and structure, and tree retention criteria (including both timber and non-timber goals and objectives). If all trees except seed trees or reserve trees will be cut, then specify seed or reserve tree objectives and characteristics, and the removal of all other trees to a minimum diameter (usually one inch DBH). For partial cuts, the characteristics of trees to cut are also delineated.

If timber management is a primary goal, and stand management objectives include the promotion of stand and tree vigor, and the production of high quality sawtimber products, then the selection of trees to cut should apply the following order of removal to achieve the desired residual stand composition and structure.

Order of Removal:

1. High risk of mortality or failure (unless retained as a wildlife tree)
2. Release crop trees
3. Low crown vigor
4. Poor stem form and quality
5. Less desirable species
6. Improve spacing

The order of removal may vary somewhat depending on landowner goals, stand management objectives, and silvicultural treatment; for example, a shelterwood seed cut or the presence of exotic invasive species may elevate the removal of undesirable species. The order of removal should be clearly stated in writing prior to any marking and cutting operations.

### Application of the order of removal:

The order of removal is most commonly applied during intermediate treatments, particularly thinning, and uneven-aged selection treatments.

- First, determine desired residual stand composition and structure, including crop tree characteristics and tree retention criteria (objectives, characteristics, number, and distribution), and target residual stocking.
- Then, select and mark trees to cut following the order of removal and until the desired residual stocking is achieved.

For example, during a free thinning applied to a small sawtimber stand managed only for timber production, first mark for cutting all high risk trees and check residual stocking. If stocking exceeds target residual, next identify sawtimber crop trees and mark the least desirable adjacent trees to provide one- to three-sided crown release. Check residual stocking. If stocking exceeds target residual, next mark for cutting low vigor then poor quality trees. Often, target residual stocking will be achieved during this step. If not, then continue to mark, focusing on undesirable species, tree spacing, and the lowest vigor and poorest quality trees that remain, until target residual density is attained. Marking stops when actual residual stocking is near the target objective stocking.

In addition to timber crop trees, other trees are typically retained to achieve non-timber management objectives (e.g., cavity trees for wildlife). Criteria for selection and retention should be specified before marking. Selecting these trees for retention may require periodic departure from strict application of the order of removal (e.g., retain some high risk trees as cavity trees and future snags for wildlife habitat). In some cases, it may be necessary to mark these trees to ensure that they will not be cut.

## TIMBER MANAGEMENT – GENERAL CRITERIA TO EVALUATE RISK, VIGOR, QUALITY, SPECIES, AND SPACING FOR TREE SELECTION

Following are definitions and specifications for terms used in crop tree selection and order of removal guidelines. Additional criteria and guidelines may be delineated for specific cover types and species.

**Risk** is the probability that a tree will die or fail (main stem will break) within a specified time period. It is an estimate of probable mortality or failure within the next cutting cycle.

- **High Risk:** Tree has any of the following:
  - Tree infected with canker rot fungus (see species specific criteria in other publications).
  - Canker affects greater than 50 percent of the stem's circumference.
  - Butternut canker affects greater than 20 percent of combined circumference of the stem and root collar.
  - White pine blister rust canker located where stem failure would cause a loss of greater than 50 percent of the crown.
  - Horizontal crack on a canker's face.
  - Open crack on main stem is in contact with another defect, such as decay, a canker, or a weak union (V-shaped).
  - Crack goes completely through the stem or is open (bark and wood fibers split) for greater than five feet of length.
  - Two open cracks occur on the same stem segment.
  - Cavity and associated decay affects greater than 40 percent of the stem's cross-sectional area.
  - Decay in main stem results in less than one inch of sound wood for every six inches in diameter (two inches for every six inches if a cavity is present).
  - Leaning tree with horizontal crack, long vertical crack, or buckling wood on the underside of the tree.
  - Leaning tree with recent root lifting.
  - More than 33 percent of roots severed, decayed, or otherwise compromised.

- Signs of cambium miners, such as two-lined chestnut borer or bronze birch borer.
  - Greater than 50 percent of the crown is dead.
  - Greater than 75 percent of the leaves subnormal in size or abnormal in color (this does not include color changes caused by nutrient deficiencies, fungal leaf spots, or other causes where crown recovery is expected).
- **Moderate Risk:** Tree has any of the following:
    - Canker affects 10 to 49 percent of the stem's circumference.
    - Cavity and associated decay affects 10 to 39 percent of the stem's cross-section.
    - 10 to 33 percent of roots severed, decayed, or otherwise compromised.
    - 10 to 49 percent of the crown is dead.
  - **Low Risk:** Tree has no signs of defect or could have all of the following:
    - Canker affects less than 10 percent of the stem's circumference.
    - Cavity and associated decay affects less than 10 percent of the stem's cross-section.
    - Less than 10 percent of roots severed, decayed, or otherwise compromised.
    - Less than 10 percent of the crown is dead.

**Vigor** refers to active healthy well-balanced growth of individual trees. It describes the tree's potential to grow at a rapid rate and increase volume. Vigor is evaluated based on tree crown class, size, and condition.

- **Low Vigor:** Suppressed trees, not free to grow. Dominant, codominant, or intermediate trees with a poor silhouette, poor leaf condition, and many branch stubs on upper and middle bole (see "High Risk"). In hardwoods, a concentric crown less than half full; in conifers, a poor crown/length ratio.
- **Moderate Vigor:** Dominant, codominant, or intermediate trees with a fair silhouette and fair leaf condition. In hardwoods, a one-half to three-quarters full concentric crown; in conifers, a fair crown/length ratio.

- **Good Vigor:** Dominant or codominant trees with a good silhouette and healthy leaves. In hardwoods, a full concentric crown; in conifers, a good crown/length ratio.

**Quality** (timber) refers to stem form, soundness, and potential timber value of individual trees. Timber quality is evaluated based on log length, diameter, and defect.

- **Poor Timber Quality:** Useable length far short of the average for the site; DBH/length ratio poor; permanently sub-merchantable in length; or heavy crook or sweep will not cut out.
- **Moderate Timber Quality:** Useable length fairly commensurate with site; DBH/length ratio fair; usable length stopper on upper bole; or moderate crook or sweep will not cut out.
- **Good Timber Quality:** Useable length commensurate with site; DBH/length ratio good; no usable length stoppers; and slight crook or sweep will cut out. Good hardwood sawtimber quality includes the potential for at least one 16 foot butt log of tree Grade 2 or better.

Effects of defects on timber quality vary significantly, depending on the type and severity of a defect, tree species, and site factors. Due to this complexity, information specific to defect types and tree species is not described here.

**Species** selection is based on sustainable landowner property goals, stand management objectives, site quality, silvics, and stand condition. Desirable sawtimber crop trees are well-adapted to the site and of commercial value.

**Spacing** refers to the distance between stems and crowns of desirable trees, and the equal distribution of growing space.

## WILDLIFE TREE AND SNAG RETENTION CRITERIA

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- Large trees for habitat structure (e.g., nest trees).
  - Some low risk, good vigor trees to sustain long life.
  - Some moderate to high risk, moderate to low vigor (decadent) trees to provide near-term future snags and coarse woody debris.
  - Desirable species; strive for species diversity.
- Mast trees for food.
  - Low risk.
  - Good crown vigor.
  - Strive for species diversity; hard-mast producers generally preferred over soft-mast producers.
- Cavity (den) trees for shelter.
  - With cavities in bole.
  - Larger diameter cavity trees are particularly desirable.
  - Strive for species diversity.
- Snags for habitat, shelter, and food.
  - Larger diameter snags are particularly desirable.
  - Strive for diversity in species and level of decay.

**Large trees** are at least 12 inches DBH, and preferably greater than 18 inches DBH. Large trees greater than 18 inches DBH are uncommon. However, they provide structural diversity that increases the availability of habitat niches and can benefit an array of wildlife. Important structural features include: tall canopies that contribute to vertical stratification, large crowns and branches, and loose, furrowed bark. Importantly, the development of large trees is required for the recruitment of large cavity trees, snags, and down coarse woody debris.

**Mast trees** are living trees that produce fruit and nuts that are consumed as food by wildlife. Large crowned vigorous trees generally produce the most mast. Increasing numbers of mast trees facilitate increased populations of some species.

**Cavity (den) trees** are living trees that are partially hollow and used by wildlife for shelter. Large diameter cavity trees, especially those greater than 18 inches DBH, can provide the greatest array of benefits. Increasing the number and size of cavity trees facilitate increased populations of some species.

**Snags** are standing dead trees. Snags benefit many species of wildlife; large diameter snags can provide the greatest array of benefits. Eventually, snags become downed coarse woody debris that also benefits wildlife and other ecosystem processes. Increasing the number and size of snags facilitates increased populations of some species. Other than the physical space occupied, snags do not compete with living trees. Retain all snags present that do not provide a threat to human safety; those that are determined to be a threat can be cut and retained on site as coarse woody debris.

## RESERVE TREES

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Reserve trees are living trees, greater than or equal to five inches DBH, retained after the regeneration period under even-aged or two-aged silvicultural systems. They can be dispersed uniformly or irregularly, as single trees or aggregated groups or patches (usually less than two acres), or any mixture thereof. They are retained well beyond stand rotation, and for purposes other than regeneration. Reserve trees may be harvested eventually or retained to complete their natural lifespan (becoming a snag and then coarse woody debris). Synonyms include standards, legacy trees, and green tree retention.

The characteristics of desirable reserve trees are highly variable and depend on the intended benefits, the species present, stand condition, and site. Desired compositional and structural attributes may be present when trees are selected and stands are rotated, or additional time may be required for development.



Typical characteristics of desirable individual reserve trees include:

- Large size (tree height, diameter, crown dimensions) for the species and site.
  - If large trees are lacking, then potential future large trees can be selected.
- Older trees with large size and rough bark.
- A mix of vigorous and decadent trees.
  - Vigorous trees of long-lived species can enable long-term retention and potentially yield a variety of benefits.
  - Decadent trees can provide current and future cavity trees, as well as future snags and down coarse woody debris.
- A mix of species, including locally uncommon species and mast trees.

The development and maintenance of large structures (vigorous trees, cavity trees, snags, down woody debris) and species diversity is typically encouraged.

Generally poor candidates for individual reserve trees include:

- Relatively small (height, diameter, crown), suppressed to intermediate trees.
- Relatively young trees within the stand.

These smaller, younger trees are retained in reserve groups and patches along with larger, older trees.

## **RESERVE TREES, MAST TREES, CAVITY TREES, AND SNAGS – RECOMMENDATIONS FOR RETENTION IN MANAGED STANDS**

Sustainable forest management is implemented within a framework defined by landowner goals and objectives, ecosystem condition and potential, and

sustainable silvicultural systems and practices. Forests are cultivated to provide a variety of socio-economic and ecological benefits. Sustainable forest management integrates multiple management goals and objectives into most silvicultural systems and the management of most stands and landscapes.

Most stands that are actively managed include timber production as a management goal (often in concert with other goals). Tree retention typically focuses on crop tree selection and regeneration methods. To satisfy multiple objectives and provide multiple benefits, retain additional trees to achieve non-timber management objectives. Integrate the following recommendations for tree and snag retention into the management of most forest stands:

### **• Even-aged Rotations**

- Retain three or more, preferably large, snags per acre if available.
- Retain reserve trees and/or patches at five to 15 percent crown cover or stand area, including large vigorous trees, mast trees, and cavity trees. Reserve trees and patches are not cut during stand rotation. Harvesting may occur in the future or may be foregone to achieve other benefits.

### **• Even-aged Intermediate Treatments**

- Retain three or more, preferably large, snags per acre if available.
- Retain three or more, preferably large, cavity trees per acre if available.
- Retain three or more, preferably large, mast trees per acre if available.
- If previously established, manage reserve trees and patches. Management may include timber harvesting or passive retention. Consider retaining three or more trees per acre to develop into large, old trees and to complete their natural lifespan. These trees may also satisfy cavity and mast tree recommendations. These trees will often become large snags and coarse woody debris.

### • Uneven-aged Systems

- Retain three or more, preferably large, snags per acre if available.
- Retain three or more, preferably large, cavity trees per acre if available.
- Retain three or more, preferably large, mast trees per acre if available.
- Consider retaining three or more trees per acre to develop into large, old trees and to complete their natural lifespan. These trees may also satisfy cavity and mast tree recommendations. These trees will often become large snags and coarse woody debris.

In cases where these recommendations for retention are not applied, then sound reasons and expected impacts of deviation should be documented.

When applying retention recommendations, be sure to consider:

- Individual trees can provide multiple benefits and fulfill the intent of more than one of the above recommendations. For example, three large oak trees with cavities could satisfy the mast tree and cavity tree recommendations, as well as the large, old tree consideration.
- Retention of both vigorous and decadent trees will provide an array of benefits.

- In general, species diversity is encouraged when selecting trees to retain.
- Large trees and snags are greater than 12 inches DBH, and preferably greater than 18 inches DBH.
- Trees retained can be scattered uniformly throughout a stand or irregularly dispersed, as single trees, groups, and patches. Retention in aggregated patches (0.1 to two acres) generally provides the most benefits. The general recommended strategy is to retain irregularly distributed patches along with scattered groups and individuals.
- Patches retained can satisfy multiple benefits. For example, at stand rotation, an unharvested buffer along a stream may satisfy Forestry BMPs for Water Quality and reserve tree retention recommendations.
- Retain as many snags as possible. Retention of snag diversity (species and size) can potentially provide the greatest array of benefits. Snags that are determined to be a threat to human safety can be cut and retained on site as coarse woody debris.
- Clearly designate, in writing and/or by marking, which trees should be retained prior to any cutting operations.

AREA (ACRES)	DIAMETER (FEET)	SQUARE (FEET)
0.1	74	66 x 66
0.25	118	104 x 104
0.5	167	148 x 148
0.75	204	181 x 181
1.0	236	209 x 209
1.5	288	256 x 256
2.0	333	295 x 295

Table Appendix A-1: Patch Sizes for Retention and Approximate Dimensions (Circular and Square)